"Constant-Distance"-Mode Scanning Electrochemical Microscopy (SECM) as a Tool for the Detection of Secretion from Cells

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Recently, it has been shown that scanning electrochemical microscopy (SECM) operated in a shear force-based constant-distance mode [1,2] can be used to image single catecholamine-releasing pheochromocytoma cells [3]. SECM-imaging was used to position the scanning probe (a 7-µm-diameter carbon-fiber microelectrode) in a controlled manner in close distance above the cell. With the probe tip held at fixed position, amperometric recordings of quantal transmitter release from these cells could be obtained upon stimulation with high KCl solution [4]. However, spatial resolution was limited because the diameter of the probe used for imaging and electrochemical detection of secretion was about half the diameter of the cell itself.

Using an electrochemical etching procedure, carbon fibers can be cylindrically etched to yield electrodes with smaller diameters [5]. These cylindrically etched carbon fibers have been successfully used to fabricate electropainted carbon-fiber microelectrodes exposing electroactive disks with diameters as small as 1 µm and having an overall tip-diameter of less than 1.5 µm. The small size make these electrodes ideal for an application as a SECM probe, especially when used in the shear-force-based „constant distance" mode for the imaging of secretory cells, and for measuring vesicular („quantal") neurotransmitter release at defined areas of the cell surface.

In this communication, we describe the use of cylindrically etched and electropainted carbon-fiber microelectrodes as novel sensors in SECM and their positioning using the shear force-based „constant-distance" mode. Due to the reduced diameter of the scanning probe an improved resolution for the imaging of secretory cells can be achieved, and hence, neurotransmitter release can be visualized at much higher spatial resolution.

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1 M. Ludwig, C. Kranz, W. Schuhmann, H.E. Gaub. *Rev. Sci. Instr.* **66** (1995) 2857-2860.
2 A. Hengstenberg, C. Kranz, W. Schuhmann. *Chemistry - A European Journal* **6** (2000) 1547-1554**.**
3 A. Hengstenberg, I.D. Dietzel, W. Schuhmann; *Eur. J. Neurosci.* **10** (1998) 1303, Suppl. 10.
4 A. Hengstenberg, A. Blöchl, I. D. Dietzel, W. Schuhmann, *Angew. Chem.* **113** (2001) 942-946.; *Angew. Chem. Int. Ed. Engl.,* **40** (2001) 905-908.
5 A. Schulte, R.H. Chow, *Anal. Chem*. **70** (1998) 985-990.

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